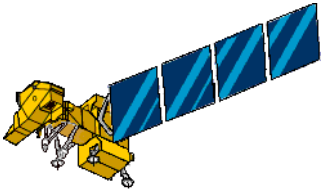


LGSOWG #27 - Special Reports

Landsat 7 Global Archive

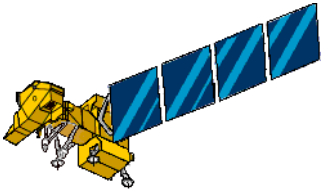
Terry Arvidson
Lockheed Martin Missiles and Space
Senior System Engineer in Landsat 7 Project Office



Long Term Plan for Data Acquisition

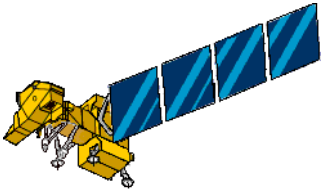
A “Long Term Plan” is being developed to define the acquisition pattern for the Landsat 7 mission in order to:

- ➔ create and periodically update a global archive ...**
 - LTP specifies frequency of acquisition for each scene over the five year mission
- ➔ of sun-lit, ...**
 - LTP filters out scenes with inadequate lighting for the time of year
- ➔ substantially cloud-free images ...**
 - LTP assigns climatology-based maximum allowable cloud cover for each scene by time of year
- ➔ of land areas.**
 - LTP is based on the subset of the Worldwide Reference System (WRS) that has been classified as land



Define “Periodic Refresh”

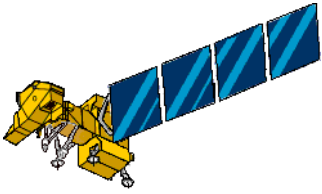
- **Each Worldwide Reference System (WRS) scene in the land data base has associated with it a set of “refresh parameters”:**
 - **Start and End Dates of the Refresh period**
 - **Number of successful acquisitions desired during that period**
 - **Minimum gap between successful acquisitions**
- **These parameters are used by the Scheduler to prioritize each scene’s need for refresh.**
- **Derivation of these parameters is the key to an effective refresh strategy.**



Derivation of Refresh Parameters

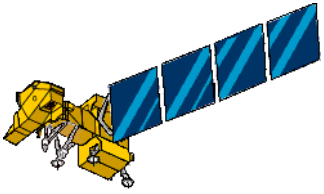
- **Some scenes change significantly during the year; others do not.**
 - **Deserts change little and can be imaged reliably.**
 - **Tropical rain forests change little, but can only be imaged reliably without cloud interference during the dry season.**
 - **Agricultural areas are often most interesting during “green up” and harvest seasons.**
- **The “seasonality index” of various land cover types was determined using mean and standard deviation NDVI values from a 10-year AVHRR data set. Refresh rates are based on this index.**
- **The science background for this approach is presented in “Terrestrial Vegetation Seasonality in the Landsat-7 Long Term Acquisition Plan”, by Dr. Sam Goward, et al., UMCP.**

(NDVI = Normalized Differenced Vegetation Index, AVHRR = Advanced Very High Resolution Radiometer, UMCP = University of Maryland, College Park)



Defining “Sun-lit”

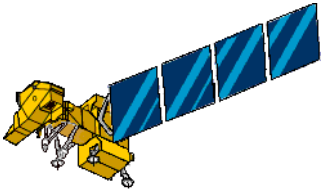
- The Scheduler has a daily solar elevation angle available for the center of each scene to be scheduled.
- A minimum Sun angle will be used to “deselect” scenes determined as too dark for acquisition. (Parameterized - currently set at 85° zenith angle)
- “Night” imaging requests are generally not part of the Global Archive refresh Long Term Plan
 - Will be considered as individual requests
 - Exception is monitoring of active volcanos, as defined by Landsat Science Team, via routine acquisition of night imagery



ETM+ Band Gain Settings

- **Analog/Digital converters for each spectral band provide two commandable settings: high gain and low gain**
- **Long term plan bundles the band gain settings as follows:**
 - **Bands 1, 2, and 3 set to the same value**
 - **Band 4 set independently**
 - **Bands 5 and 7 set to the same value**
 - **Band 6 in Format 1 always set to Low; Format 2 always set to High**
 - **Band 8 (Pan) always set to Low**
- **Scene entropy values used to determine gain settings**
 - **Low gain and high gain entropies calculated for each scene**
 - **Gain assignment based on the highest entropy value**
 - **The science background for this approach is in the process of publication, by Dr. Sam Goward, et al., UMCP.**

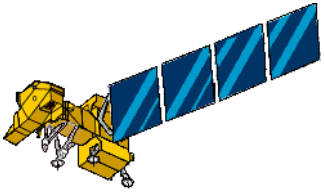
(UMCP = University of Maryland, College Park)



Defining “Substantially Cloud-free”

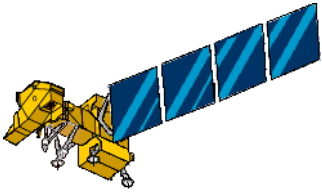
- **ISCCP climatology data set was used to determine nominal expected cloud cover values for each scene for each month**
- **Daily cloud predicts from National Weather Service are used to avoid imaging very cloudy areas by altering scene priority:**
 - **Boosted if predict is better than nominal expected value**
 - **Reduced if predict is worse than nominal expected value**
- **An Automated Cloud Cover Assessment (ACCA), as well as other quality checks, is performed during Level 0R processing, recorded in scene metadata, and sent to scheduler**
- **ACCA is compared to nominal expected cloud cover value**
 - **If better than nominal, scene is labeled as successfully acquired**
 - **If equal to or worse than nominal, scene is labeled as unacquired and a candidate for scheduling at the next opportunity**

(ISCCP = International Satellite Cloud Climatology Project)



Defining the Earth's Landmass

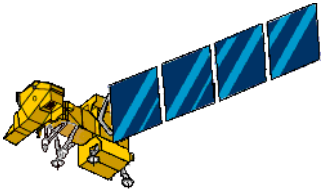
- **Chose every WRS scene containing land within its boundaries:**
 - All continents, with Antarctica starting at minimum ice pack limits
 - Arctic islands
 - Inland seas and bays to extent that the WRS scene contains any land
 - Unnamed islands, shoals, reefs, rocks, banks
 - Within vast shallow coastal areas (<200m deep)
 - Scenes close to continental coasts and well within the shallows
- **Our current land data base contains approximately 14,000 WRS scenes**
 - about 850 land scenes on an average day
- **Flywheel scenes (up to 2) also included**



LTP Structure

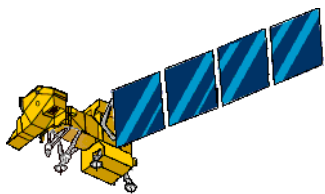
- **LTP comprises four files:**
 - **nominal cloud cover (each WRS / monthly values / 1 year)**
 - **default solar zenith maximum angle (single value = 85P)**
 - **default band gain values (each WRS / monthly values / 1 year)**
 - **global archive requests (each WRS / 8 years)**
- **Good initial cuts of each now in the Scheduler data base and undergoing review**
 - **expect revisions via internal UMCP review**
 - **expect revisions via results of LTP characterization runs**

(UMCP = University of Maryland, College Park)

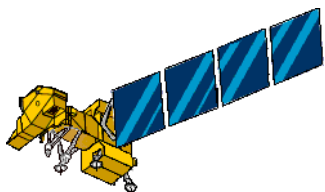


Fine Tuning The Process

- **Algorithm for scheduling ETM+ imaging is built on a database of scene parameters from the Long Term Plan, each adjustable. They include:**
 - Refresh rate
 - Landmass definition
 - Sun angle maximums
 - Cloud cover thresholds
 - Band gain settings
- **We get feedback**
 - on the performance of the predicted cloud cover versus the calculated cloud cover for each acquired scene
 - from Landsat 7 Science Team and Image Assessment System
 - from analyzing scheduler performance reports
- **Emphasis is on optimizing acquisition performance, and quality and usefulness of archive contents.**



Backup Chart



Default Gain Settings for Night Imaging

- **BAND:** 1 2 3 4 5 6 6 7 8
 GAIN: H H H H L L H L L
- **Bands 1-4 are set to H, the most likely value for day scenes**
- **Bands 5 & 7 set to L, per Science Team analysis results**
- **Band 8 (Pan) set to L, the preset value for all day scenes**